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Remarks:					
<p>Chick - This is report on trip by [redacted] [redacted] to initiate the P. I. Performance Study we're doing (the one [redacted] is so interested in),</p> <p><i>Thank you, glad to see you're underway.</i></p> <p><i>ch</i></p>					
FOLD HERE TO RETURN TO SENDER					
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FROM:

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25 June 1964

MEMORANDUM FOR THE RECORD

JWC

SUBJECT: Trip Report, 9-12 June 1964, [REDACTED]
[REDACTED] "Research on Photo Interpreter
Performance."

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1. Participants in the unclassified seminars and discussions relating to the [REDACTED] contract "Research on Photo Interpreter Performance" included: [REDACTED]

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2. The program was planned by [REDACTED] for the purpose of clarifying the photographic, psychometric and practical aspects of the research project. For our mutual understanding of the techniques and our handling of the terminology associated with the project, [REDACTED] people reviewed photographic and optical concepts as well as modulation transfer function of an entire system. We toured the two [REDACTED] plants, inspected their lens-making facilities, and examined in detail two camera systems developed there. (One was a 35mm, 40-lb. tracking camera used in high-altitude photography.) [REDACTED] exposed us to some microdensitometry in the process of determining edge gradients and then led us through the lab procedures for making a "GEM."

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3. [REDACTED] and his people profiled the psychometrics and statistical analysis involved in a human factors study. [REDACTED] discussed the photointerpretation process (at an unclassified level) with informal contributions from [REDACTED]

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4. The time together in [REDACTED] served mainly for nailing down the theoretical bases of the project. Some time had been set aside, though, for [REDACTED] to discuss special project matters. Some of the points of concern that were raised:

a. We had been concerned that a P.I.'s possible familiarity with domestic targets might interfere with objective results. It was decided, however, that since the test would be asking pointed questions about specific details in a particular target-type, then knowledge of the overall site was not a disturbing factor. Also, the format of the GEMS is such that the coverage can be selective and an appropriate (10 x 1.0 statute miles) flight path laid out. We have anyway avoided sites that are visited by P.I.'s on the regularly scheduled field trips.

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declassification

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SUBJECT: Trip Report -- [REDACTED]

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b. The painfully slow process of locating existing photography of sites was considered, and we weighed the value of having complete coverage before attempting to fly the targets. We concurred that full preliminary coverage was necessary for, because of the low altitude and small field of the final photography, we must be able to plan precise flight paths over each target. Also, since the material we will gather in the overflights will take care of the two other important phases of the study (stereo & color), this stage requires substantial planning.

A meeting was planned with [REDACTED] OSA, the following week to discuss the possibility of flying some "quick and dirty" reconnaissance over targets for which existing photography has not been located.

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5. The exchanges at the seminars, across different fields, were not only reassuring for us to witness but also extremely valuable for the contractors in dealing with one another on the project. They have established a high degree of common knowledge (and proficiency) in one another's specialties: this provides an excellent check's-and-balance.

6. The experimental design of the project falls pretty much in line with the pilot study -- although its execution is on a far more elaborate scale, of course. There are details about which I personally have had reservations and for which I have thought changes (from the pilot study) might eventually be warranted. These details concerned:

- a. the compromise of varying image scale for the sake of keeping spatial resolution (of the film) constant and varying ground resolution;
- b. the analogy between the "GEMS" (as well as the handling procedures and equipment designed for testing with them) and operational materials and interpretation techniques.

7. However, there is no evidence of complacency on the contractors' parts: they seem to have a great deal of integrity about this project and have thus far, to our satisfaction, justified their approaches and techniques. [REDACTED] has been helpful in informally evaluating some of the technical aspects with me.)

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8. I do suggest that in framing the final results [REDACTED] be encouraged to use his full professional voice. I suppose I'm asking for a perspective on the project which some of us can assume but which should be reinforced for the project's recipients and beneficiaries. This particular piece of research involves far more than deriving and attaching numbers to resolution, stereo and color: it sets a precedent for itself in the context of our total effort.

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[REDACTED] Development Branch, P&D

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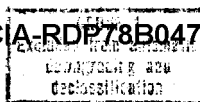
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THE ANALYSIS OF MISSILE SITES AS A FUNCTION OF PHOTOGRAPHIC GROUND RESOLUTION

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THE ANALYSIS OF MISSILE SITES AS A FUNCTION
OF PHOTOGRAPHIC GROUND RESOLUTION

Technical Report 723-10



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January 1968

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ACKNOWLEDGMENTS

We sincerely thank the photointerpreters and intelligence analysts who participated in this study. It is obvious that without their help, the study could not have been done. We would like to thank them by name but, unfortunately, we are not permitted to.

We also thank for conscientious and skillful assistance. The success of the data collection phase of the project can be attributed almost entirely to him.

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INTRODUCTION

The study reported here was an experimental investigation of the relation between the ground resolution of aerial photographs and the information about missile sites that can be obtained from them.

The intelligence community is frequently faced with the problem of assessing the cost of proposed photographic reconnaissance systems in relation to the intelligence information they will yield. Modern systems are enormously expensive and their costs are generally related to the quality (ground resolution) of the photographs they produce: better photography usually implies greater system cost.

A difficult problem in assessing proposed systems is determining what additional intelligence information a more expensive system will provide to the intelligence community. An even more difficult problem is determining the value of the additional information to the nation and its security. The information that is valuable today may not be valuable tomorrow, and the information that will be valuable tomorrow cannot be determined entirely today. Such a state of affairs has contributed to the failure of efforts to quantify intelligence information and to the lack of a useful functional relation between photographic intelligence information and system cost.

The relation between the *value* of the intelligence information a system will yield and its cost probably cannot be determined objectively or experimentally; consequently, this investigation was directed toward the other problem: determining *what* additional intelligence information better ground resolutions will yield.

It would be desirable to know what information can be obtained about all classes of targets as a function of ground resolution, for example, missiles, electronics, aircraft, shipping, and so on. However, such an effort was not possible within the scope of this project and a single class of targets had to be selected for study. Consequently, meetings were held with intelligence analysts (IAs) and photointerpreters (PIs) to determine what types of targets were most important to the intelligence community. Documents prepared by intelligence-gathering planners were also examined. As a result of these meetings and the review of relevant documents, the decision was made to use domestic ICBM sites as targets.

Additional meetings were held with the IAs and PIs to determine, first, what ICBM information the IAs were requesting from the PIs and, second, what information the intelligence community wanted from the IAs, regardless of whether it came from photographs or other sources. Also, during this planning phase, the experimenters visited Vandenberg AFB to obtain preliminary "ground truth" information on U. S. ICBM sites.

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METHOD

The study method was designed to simulate operational photographic intelligence practices. First, photographs with carefully specified physical characteristics and known ground resolutions were prepared. Two PIs independently read out the photographs, and with the aid of tracing paper and an enlargement of the photographs, they prepared an annotated sketch. Each pair of PIs then worked together to achieve a consensus read-out. The resulting, final annotated sketch and the enlargements were delivered to intelligence analysts who specialize in analyzing missile sites. They evaluated the PIs' read-out and prepared a report on the target.

The Photographic Stimuli

Domestic missile and missile related sites were selected as targets. The original photography was collected during the summer months of 1965. To achieve the required ground resolution, an RB-57 aircraft was flown at 160 knots at approximately 2,000 feet altitude. The photographs were taken with two Maurer KS-67A (P-220) cameras cycling once per second and equipped with lenses of three-inch focal length set at f/4. The optical and mechanical functioning of the cameras was carefully adjusted and calibrated. The two cameras made stereographic pairs of photographs; the cameras were pointed fore and aft along the flight path at a 10 degree angle from Nadir, providing a 20 degree stereo-convergence angle¹. No filters were used. The exposure time was .002 second. Whenever possible, a time of day yielding sun angles of 20-30 degrees was chosen. Kodak Special Panatomic-X Aerial Film, Type SO-136, was used and uniformly processed to yield a gamma of 1.00.

From the collected photography, 10 target sites were selected for use in this study. The selected targets are listed in Table 1.

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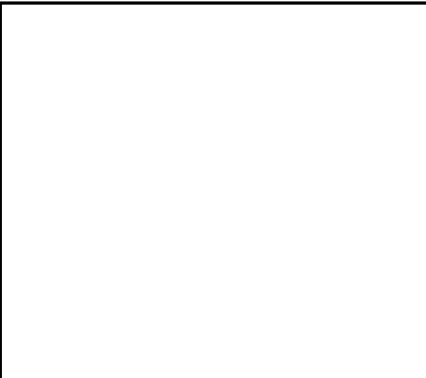
Table 1. The Targets

<u>Target Number</u>	<u>Description</u>
1	Minuteman II Launch Facility
2	Minuteman II Launch Facility
3	Minuteman II Launch Facility (under construction)
4	Minuteman II Launch Facility (under construction)
5	Minuteman II Launch Facility (under construction)
6	Minuteman II Launch Control Center
7	Titan II Launch Facility
8	Research and Development Launch Facility (Saturn I)
9	Missile Display at Cape Kennedy
10	Camera Pads (a mislead)

Detailed "ground truth" was obtained for each target by using information from photography, site visits, engineering drawings, and other collateral sources; thus, each of the targets was thoroughly described.

The original negatives were used to prepare GEMS², which are photographic reproductions exhibiting specific image-structure characteristics³. The GEMS were positive transparencies and were made to the same scale as the original negatives, 1:8000. The simulated modulation transfer functions and granularities used resulted in a set of GEMS with the seven resolution levels listed in Table 2.

Table 2. Resolutions of the Photographs

<u>Resolution Numbers</u>	<u>Resolutions</u>	
	<u>Spatial Frequency</u> <u>(Lines/Millimeter)</u> <u>of GEMS</u>	
1	40.00	
2	26.30	
3	16.70	
4	13.35	
5	7.82	
6	5.16	
7	3.27	

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²Trademark of

³F. Scott, Photographic image simulation, *J. Phot. Sci.*, 12:139, 1964.

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The resolutions corresponded to those given by a high-contrast three-bar target⁴. These resolutions were obtained by adjusting the size of the Gaussian-shaped point spread function and granularity so that the resolution values corresponded to the spatial frequency of the modulation transfer function at a modulation transfer factor of 0.25. The GEMS therefore exhibited characteristics similar to those which would be obtained with operational photography at these resolutions. The ground-resolution values were selected to encompass the range of existing systems and of most of the proposed future systems.

The modulation transfer function and paper prints of one target at each of the seven resolutions are shown in Appendix A. Paper prints of each target are shown in Appendix B.

Target-by-Resolution Combinations Used

Because of the limited number of experienced PI subjects and the limited number of man hours available, it was not feasible to use all 10 targets at all seven resolutions. A total of 52 target-by-resolution combinations was used. They are shown in Table 3.

Table 3. Target-by-Resolution Combinations Used in the Study (Indicated by Xs)

Resolution Number	→	Target Number							
			1	2	3	4	5	6	7
		1	X		X		X	X	X
		2	X		X		X	X	X
		3	X	X	X	X	X	X	X
		4	X		X		X		X
		5	X		X		X		X
		6	X		X		X		X
		7	X		X	X	X	X	X
		8	X		X	X	X	X	X
		9	X		X	X	X	X	X
		10	X		X		X	X	X

As can be seen from Table 3, all targets at resolutions [redacted] were used in the study.

⁴ Mil. Std. 150-A.

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SECRET*Subjects*

The subjects were 20 professional PIs, and all were specialists in interpreting missile sites. Their experience in interpreting missile sites ranged from two to 10 years, with a median of five years.

The 20 PIs, 10 from PAG and 10 from IAS, were divided into 10 teams of two men each. The team assignments were made by randomly pairing the 10 PIs from PAG with 10 from IAS. These random pairings were modified in instances where two less experienced individuals were paired and where a potential working incompatibility, either because of schedules or personalities, was discovered.

Procedure

As mentioned, during the planning phase of the study, four IAs were interviewed to determine the types of missile sites that would be most appropriate and the kinds of information about those sites the intelligence community would want. In addition, the manner in which the photographic intelligence could best be communicated from PI to IA was discussed. The IAs requested an annotated sketch and an enlarged photograph of each site.

It was found in preliminary experimentation that the scales of the sketches produced by the PIs differed greatly; generally speaking, the better the resolution of the photograph, the larger the scale of the sketch. However, even with the same ground resolution, different PIs produced sketches of different scale. Consequently, a method of controlling the scale of the annotated sketches at each ground resolution was required.

The decision was made to have the PIs make their sketches on tracing paper placed over a paper print enlargement of one frame of the stereo pair he was viewing. The photographs representing the different ground resolutions were enlarged different amounts, so that the spatial frequencies of the enlarged paper prints would be constant. A spatial frequency of approximately 2.2 lines/mm was chosen so that naked-eye viewing would be possible and the capabilities of the available photo lab would not be exceeded.

Table 4 shows the specifications of the paper prints that the PIs used to prepare annotated sketches and that the IAs used along with the sketches to evaluate the PIs' responses.

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Table 4. Specifications of the Enlargements Used by the PIs in Preparing Annotated Sketches

Resolution Numbers	1	2	3	4	5	6	7
GEM Ground Resolutions (Inches)*							
GEM Spatial Frequencies (Lines/mm)	40.0	26.3	16.7	11.4	7.8	5.2	3.3
Print Enlargement Factor (x)	17.8	11.8	7.4	5.0	3.5	2.3	1.5
Print Size (Inches Square)	40	26	16	11	8	5.2	3.3
Print Scale	140	678	1080	1600	2280	3480	5330
Print Spatial Frequency (Lines/mm)	2.2	2.2	2.3	2.3	2.3	2.3	2.2

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*As previously noted, the scale of the photographs (GEMS) viewed and "read-out" by the PIs was approximately constant at 1:8000.

Two experienced intelligence analysts, both specialists in strategic missile sites, studied the PIs' responses and evaluated their worth for intelligence purposes. The first analyst prepared a written report for each scene at each of the resolutions employed. The second analyst independently examined the sketches and enlargements and then critiqued the written reports. The reports were revised where necessary, but for the most part, the second analyst merely corroborated the findings of the first.

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RESULTS

The reports prepared by the IAs for each target-by-resolution combination used in the study were the "data" available for analysis to determine the effects of ground resolution on photographic intelligence output. The IAs' reports were prepared from the PIs' annotated sketches and the paper enlargements. Each IA report was analyzed individually to determine what reports might be combined to simplify the presentation here. Generally speaking, though the results were similar for all targets, it appeared that the results for the Minuteman II targets might be presented more logically in one section and the results for each of the other five targets presented in separate sections.

TARGETS 1 THROUGH 5: MINUTEMAN II SITES

Following is a summary interpretation and analysis of five Minuteman II sites as a function of ground resolution.

Resolution Seven Targets 1 through 5)

"Unidentified activity within a secured area, probably military." This quotation accurately summarizes the reports on all five sites at this 97" ground resolution.

Resolution Six Targets 2, 3, and 4)

At this resolution, a hardened, single missile silo could be identified with reasonable certainty. However, the analysts reported they could not perform any "substantive analysis," or "meaningful analysis."

Resolution Five Targets 1 through 5)

At this resolution, the PIs and IAs were able to identify a single silo, hardened missile site. They were able to determine whether or not the site was completed or under construction. However, there were discrepancies among the PI reports and inaccuracies. Many of the objects that were identified, e.g., vehicles, construction equipment, fences and terrain features, were not relevant to a weapon system analysis.

⁵ Ground Resolution

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25X1 Resolution Four [] Target 3)

Following is a summary of the analysts' comments. This resolution was sufficient for "analysis and comments on the nature of the weapon system to be employed.... Such analyses on previous resolutions (Five, Six, and Seven) would have either been impossible or involved too much guesswork."

"The weapon system to be deployed at this facility is probably the same type missile as those assigned to the facilities in target frames 1, 2, 4, and 5. Careful study revealed nothing to change the judgments and comments made on system parameters in Target 5, Resolution Three write-up. It is only slightly more difficult to derive the same amount of intelligence analysis from this frame than it was in the study of Resolution Three, Target 5."

To summarize, on the basis of the results from one target, the IAs concluded there was little difference in the information that could be obtained from [], as opposed to a [] ground-resolution photograph. The information might be "only slightly more difficult" to get from the 28" ground-resolution photograph.

25X1 Resolution Three [] Targets 1 through 5)

It will be recalled that the intelligence analysts examined one target at a time, going from the poorest to the best resolution, and that each target was not analyzed at all resolutions. Targets 1 and 2 were analyzed at Resolutions 7, 6, 5, 3, and 1. Targets 4 and 5 were analyzed at Resolutions 7, 5, 3, and 1. Target 3 was analyzed at all seven resolutions. Because of the different resolutions for the five Minuteman II targets and the fact that the analysts referred to previously examined resolutions in analyzing one target at a given resolution, it is necessary at this point to discuss the specific targets.

25X1 The analysts reported for Target 3 that the quality of Resolution Three [] was better than Resolution Four [] but that it "really doesn't permit any more analysis."

The analysts reported correctly that Target 2 was an operational, single hardened missile launch silo. They further reported that Target 2 appeared similar to Target 1 and that "the analysis of Target 1, regarding missile system parameters, is also equally applicable to this site [Target 2]."

Following is a summary of the analyses of Targets 1, 4, and 5 at Resolution Three. At this resolution it was possible for the analysts:

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1. To confirm that these facilities were single silo, hardened missile launch sites.
2. To distinguish between sites under construction and the completed sites.
3. To infer inertial guidance because of the absence of guidance antennas and cable scars.
4. To infer storable liquids or solid propellants because of the lack of propellant handling or storage facilities.
5. To infer a "fly-out" launch technique because of the simplicity of the external configuration of the silo and the apparent lack of exhaust ports.
6. To infer a "rapid reaction time" because of the lack of personnel housing.
7. To doubt a refire capability because of the lack of "fixed loading gear above ground," and the "unlikelihood of a second missile being stored underground."
8. To infer moderate hardness and the ability to "derive a general estimate of psi hardness" by measuring the silo door and the spacing of the door tracks.
9. To infer vulnerability has been decreased by separating the launch silos because the "facility appears to be complete within itself."

25X1 Resolution Two Target 3)

The analysts concluded that the "excellent quality of the photo allows a much better look at the facility," but that the "primary value of this resolution in this series is to confirm analytical judgments derived earlier regarding system parameters of the missile involved."

25X1 Resolution One Targets 1 through 5)

The analysts' summaries are quoted verbatim:

Target 1. "Clarity of this resolution permits better visual observations and, of course, more precise mensuration, which simplifies photographic interpretation work. Otherwise, it is of little value for additional missile systems analysis."

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Target 2. "This resolution would, naturally, be most desirable for analytical purposes but is redundant with respect to Resolution 3. It provides no new intelligence information."

Target 3. "Best quality, of course, but redundant coverage for this exercise. No new information can be provided by this photo."

Target 4. "The much greater clarity of details at this resolution confirms analysis made on the Resolution 3 photo and, of course, permits more accurate mensuration. The type of work activity around the surface of the silo suggests final "fitting-out" or modification of the silo or, perhaps, servicing of a missile within the silo. Also, the presence of numerous automobiles in the area indicates that this is most likely a U. S. missile launch site."

Target 5. "Greater clarity confirms previous analysis on this series of prints. There is still no evidence of vents or exhaust ports around the silo; however, if the missile utilizes solid propellants, the space between the missile's exterior surface and the wall of the silo would likely be adequate for venting the initial launch exhaust. Also, it is for this reason that an approximate estimate of missile diameter cannot be determined from measuring the silo diameter."

Conclusions from the Analysis of Targets 1 through 5

The results of the Minuteman II target analyses strongly indicated that for the analysis of single silo missile systems, a photographic ground resolution of [] is no better than a ground resolution of []. Though only one target was analyzed at all ground resolutions, the results of that analysis indicated that ground resolutions of [] provided little additional missile system information as compared to a ground resolution of []. However, the information was "slightly more difficult" to get at [].

The better resolutions [] appeared merely to confirm what could be learned at resolutions of [] and possibly []. They probably also gave the PIs and analysts greater confidence in their conclusions and assurance that they had not overlooked significant information.

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TARGET 6: MINUTEMAN II LAUNCH CONTROL CENTER

25X1 Resolution Seven ☐

The IAs reported that there was "no intelligence value" in this photograph.

25X1 Resolution Five ☐

At this resolution, it was possible to determine that the target is "a secured area with a possible electronics function." Hardstands and buildings could be identified with some certainty. However, the PI report was confusing to the IAs.

25X1 Resolution Three ☐

At this resolution, it was possible for the IAs to state that the facility "probably has a missile guidance/control function for one or more missile launchers." The conclusion was based upon "the positive identification of several hardened antennas of different sizes; a large, soft antenna, a central control building and bunkering, all within a secured area."

The two PI reports were conflicting with respect to one hardened antenna--a circular concrete pad. One said it was a missile launch silo; the other correctly identified it. The analysts were able to resolve the conflict correctly. They saw no evidence of a silo cover or door and, in addition, reasoned that a launch silo would not be placed so close to antennas and the control building.

25X1 Resolution One ☐

The resolution of this photograph served primarily to substantiate the conclusions derived from Resolution Three. The analysts concluded that Resolution Three "provides an optimum of qualitative and quantitative data for analysis of this target." They concluded further that Resolution One "gives us a better look at what we can see in the Resolution Three photo and provides the basis for a little more accurate measurements."

Conclusions from the Analysis of Target 6

25X1 Within the resolutions studied ☐ all of the relevant photointerpretation intelligence was obtained from the ☐ resolution; the ☐ resolution apparently
25X1 served only to increase the analysts' confidence in the conclusions derived from the ☐ resolution.
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TARGET 7: TITAN II MISSILE LAUNCH FACILITY

25X1 Resolution Seven

The PIs reported that the facility was a hardened missile launch silo with the cover door closed. That report was correct, but the analysts reported that the resolution was "too poor for any substantive analysis."

25X1 Resolution Six

The existence of a single missile launch silo could be confirmed at Resolution Six, and the tracks or rails for the sliding, silo cover door could be identified. Other objects within the secured area could not be identified. But the analysts were able to conclude tentatively that this was not the same type of missile system as the Minuteman II.

25X1 Resolution Five

"Hardstands" of different shapes and sizes, as well as a quonset building outside of the secured area, were identified. Pattern of "hardstands" confirmed that the site was different from Minuteman II sites. The analysts inferred that the "hardstands" on each side of the silo were for parking fuel and oxidizer trailers and, on this basis, concluded that the missile uses liquid rather than solid propellants.

25X1 Resolution Four

Large, soft communications antenna were identified. Propellant trailer "hardstands" were confirmed. Some of the so-called "hardstands" identified by the PIs were inferred to be hardened antennas by the analysts, and on the basis of this inference, they concluded that the missile used radio-inertial and not all-inertial guidance.

25X1 Resolution Three

At this resolution, the microwave tower, antenna masts, and subsurface air-conditioning bunker were identified. The lack of a missile storage area, handling and erection equipment, implied to the analysts that the site does not have a refire capability.

25X1 Resolution One

This photograph permitted confirmation of what was found at Resolution Three, and the identification of additional objects in the area. But the analysts felt that the additional descriptive data made available by this improved resolution had "negligible value for deriving any additional missile intelligence from this target."

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Conclusions from the Analysis of Target 7

At Resolution Seven the presence of a missile site could not be confirmed, in spite of the fact that both the PIs and the IAs knew the targets of interest were missile sites and no search was involved. Resolution One provided confirmation of the data obtained from Resolution Three, but it did not provide additional significant intelligence.

TARGET 8: RESEARCH AND DEVELOPMENT LAUNCH FACILITY (SATURN 1)

25X1 *Resolution Seven*

At this resolution the IAs concluded that the target "is possibly a missile/space test facility...for static testing or actual launchings." They could tentatively identify "two test/launch positions with connecting cable scars to a common control building or blockhouse."

25X1 *Resolution Six*

The IAs reported that this resolution was sufficiently improved to state that the "installation is probably a two-position missile/space *launch* facility. Large shadows cast by probable gantries indicate one is in position on pad and the other is to rear of launch pad." The complexity of the site indicated it was a research and development facility and not a deployed site. The IAs were able to determine that "little or no concern had been given to...site hardening, vulnerability, and refire capability." The IAs concluded: "The relative size of the gantries indicate that large test vehicles are involved. Pad separation distance and distance from pads to control center are tenuous data inputs for determination of maximum thrust levels of vehicles launched from these pads. Cannot get much else from this photo."

25X1 *Resolution Five*

At this resolution, a large number of tanks could be identified, indicating the facility was designed to launch missiles using liquid propellant. No evidence could be found indicating the type of guidance system employed. The IAs reported that the "launch pads appear to be elevated, with single large flame detectors on the downrange side of pads."

25X1 *Resolution Four*

At this resolution, pipeline patterns, light poles, underground entrances, and other objects could be identified, but the IAs reported "nothing noteworthy for intelligence purposes" was discernible. "Still no evidence of guidance or other types of antennas. Since this is an R&D facility, such equipment may be centrally located to serve these launch pads and others which undoubtedly exist nearby."

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Resolution Three []

Following is the IAs' report for this resolution []
 [] "Vast amount of detail now visible and adequately described by photographic interpreters. Most of it is non-essential for solving basic missile intelligence problems, but some is useful for a better understanding of the layout and general operational activities of this facility. If missiles or missile components were present, they would be readily observed at this resolution and could be measured with reasonable accuracy. This data, of course, would be quite useful along with inputs from other sources for determining some of the missile's performance characteristics."

Resolution One []

The IAs reported "excellent detail is visible at this resolution but nearly all is redundant to what can be seen and measured in Resolution Three."

Conclusions from the Analysis of Target 8

The most important conclusion is that the best resolution [] produced no additional relevant intelligence, as compared with a [] resolution.

TARGET 9: MISSILE DISPLAY AT CAPE KENNEDY

Resolution Seven []

The IAs reported that the PI reports were incomplete and "surprisingly incorrect," in spite of the fact that in the IAs' view the photograph yielded "a considerable amount of identification-type intelligence information." The site signature was identified as a "classical pattern for a pair of missile/space launch pads." The control blockhouse serving both pads and the cable scars leading to them could be identified. The shadow of a large object on one pad led the IAs to infer the probable presence of a missile/gantry service tower. Its size suggested that large missile/space vehicles were launched from the pads and that the facility was located at a "test rangehead." Linear objects on the other pad were correctly identified as missile components or missiles; however, the presence of several such objects on one pad puzzled the IAs.

Resolution Six []

As previously stated, in preparing their analyses, the IAs used two annotated sketches that were prepared independently by two PIs, plus an annotated sketch that was prepared

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jointly by them. The IAs reported that for Target 9, Resolution Six, only one of the PI reports (annotated sketch) was of value. In it, the two launch pads, the blockhouse, the cable scars, and the gantry tracks connecting the launch pads were correctly identified. Because a single gantry "obviously" serves both pads, the IAs concluded that only one missile at a time can be assembled and checked out at the pair of pads. An additional correct inference was that the pads were completely soft. The function of the facility at the time the photographs were taken was still puzzling because of the "missile-like components in the launch area. Better resolution is needed to clarify this phenomenon."

25X1 Resolution Five

At this resolution, several missiles, components of various types of missiles, and a three-stage missile in a horizontal position with its stages separated were detected. These detections led the analysts to infer that "these launch pads are not currently used for line firings. The make-up and layout of the various objects suggest that the present function of this facility is for missile display and/or training purposes."

25X1 Resolution Four

The IAs reported that "this resolution confirms beyond all doubt that this facility is not presently an active launch area and that it is now used for the display of missiles and missile-handling equipment." Several missiles were identified by type--Atlas, Thor, Titan I, and so on. Aerodynamic missiles could be distinguished from ballistic missiles. The IAs reported that other features of intelligence value could possibly be discerned at this resolution: number of stages, number of nozzles in the booster stage, shape of the nose cone, and the number of engines in the booster stage when they are clustered.

25X1 Resolution Three

The IAs reported that visibility was improved at this resolution, "but not enough to provide significant new intelligence data. Most of the noteworthy missile intelligence which could be derived from aerial photography of this facility was obtained from Resolution Four of this series."

25X1 Resolution One

The IAs reported "Next best thing to being on the ground! Possible Mark IV reentry vehicle, Polaris missile

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and possible Pershing missile in vertical positions can be readily detected." However, they then expressed this opinion: "Resolution of this quality makes life easier for the photographic interpreter but offers little additional information which is applicable to systems analysis. This is mainly due to the inherent limitations of photography as a source of data which can be used to determine missile system parameters."

Conclusions from the Analysis of Target 9

For this target, the results strongly indicated that resolutions of [] provided no more intelligence information than a resolution of []

25X1

TARGET 10: CAMERA PADS (MISLEAD)

At a poor resolution or small scale, this site resembles a missile site; there are good roads and concrete pads. But the pads are only for cameras and, as previously mentioned, the photograph was included in the study as a mislead.

Resolution Seven []

"Unidentified activity in an isolated area." Nothing more could be said by the PIs or IAs. (It seems probable to the writers that if the PIs had been searching, not even that would have been said; either they wouldn't have seen the target at this resolution, or having seen it, they would have ignored it.)

Resolution Six []

The PIs and IAs reported no clues as to the function of the facility. The site signature indicated a possibility to them: "launch/firing positions for mobile missile launchers or artillery pieces."

Resolution Five []

PIs reported two positions as missile launch points with 50% confidence. The IAs inferred that if the PIs were correct, the missiles would have to be small tactical weapons, because of the simplicity of the launch positions and the lack of turn-around space for large vehicles or carriers.

Resolution Three []

The function of the installation could not be determined at Resolution Three. The resolution was reported by the analysts to be good enough to identify missile and propellant-handling equipment, storage equipment, and antennas if they were present. "Total absence of these items prevents

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firm identification as a missile-related facility. However, the "positions could be pads/hardstands for mobile instrumentation equipment."

25X1 Resolution One ☐

Better resolution did not help the PIs or the analysts to answer the question of the function of this installation.

Conclusions from the Analysis of Target 10

The experimental subjects, both the PIs and the analysts, expected to see missile sites; that was their "set," because they knew the purpose of the experiment and the kinds of targets that were being used. Consequently, their inferences concerning this photograph, regardless of the resolution, must be tempered. The important conclusion is that Resolution One did not lead to modifications of the inferences derived from Resolution Three.

READ-OUT TIME

25X1 A record was kept of the amount of time it took the PIs to read out each of the 10 targets at resolutions of ☐ ☐ 25X1
25X1 ☐ The mean amount of time taken, computed across all targets and subjects, was 20 minutes for the ☐ 25X1
25X1 ground resolution, 40 minutes for the ☐ ground resolution, 72 minutes for the ☐ ground resolution, and 110 minutes for the ☐ ground resolution. In short, the better the resolution, the greater the amount of time taken to read out the target.

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SUMMARY OF CONCLUSIONS

In the analysis of missile sites using aerial reconnaissance photography, most, if not all, of the significant intelligence information can be obtained from [] ground resolution photography. Ground-resolutions of [] and [] provide little, if any, additional significant intelligence information regarding this class of targets.

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DISCUSSION

The data resulting from this study were verbal reports, not quantities, yet they were convincing. For the analysis of missile-site targets, photographic systems that produce ground resolutions better than [] are *not* required and would probably represent an unwarranted expenditure of money.

25X1

On the other hand, it must be emphasized that *only missile and missile-related sites were used as targets in this study*. Had electronic facilities or tactical targets been used, the results may have been different. With such targets, *even the [] ground-resolution photography may not have yielded all of the intelligence information that could be obtained from aerial photography*. The implication is obvious; a similar study must be done with a different class of targets.

25X1

As mentioned in the introduction to this report, the study was designed to simulate photo-intelligence practices. However, other than the fact that the IAs were given the scale of the annotated sketches, they were not given any mensuration data for their analyses, and mensuration is an integral part of both photographic interpretation and analysis.

The IAs reported several times that the better resolution photography [] would yield more accurate measurements. This is probably correct, but the *significant* questions are: *How much more accurate?* and *Does the increase in accuracy produce additional significant intelligence information?* These questions should be answered experimentally, and an initial effort to answer them has been made: []

25X1

The measurement of photographic images by human operators.

[]

25X1

The data presented regarding read-out time may be misleading. As previously mentioned, the PIs were instructed to provide as much detail as they could in preparing their annotated sketches. At the better ground resolutions, much of the detail was irrelevant, yet the PIs required additional time to provide it. If the PIs had been asked to answer the same number of questions at each resolution, they probably would have spent less time answering them at the better resolutions.

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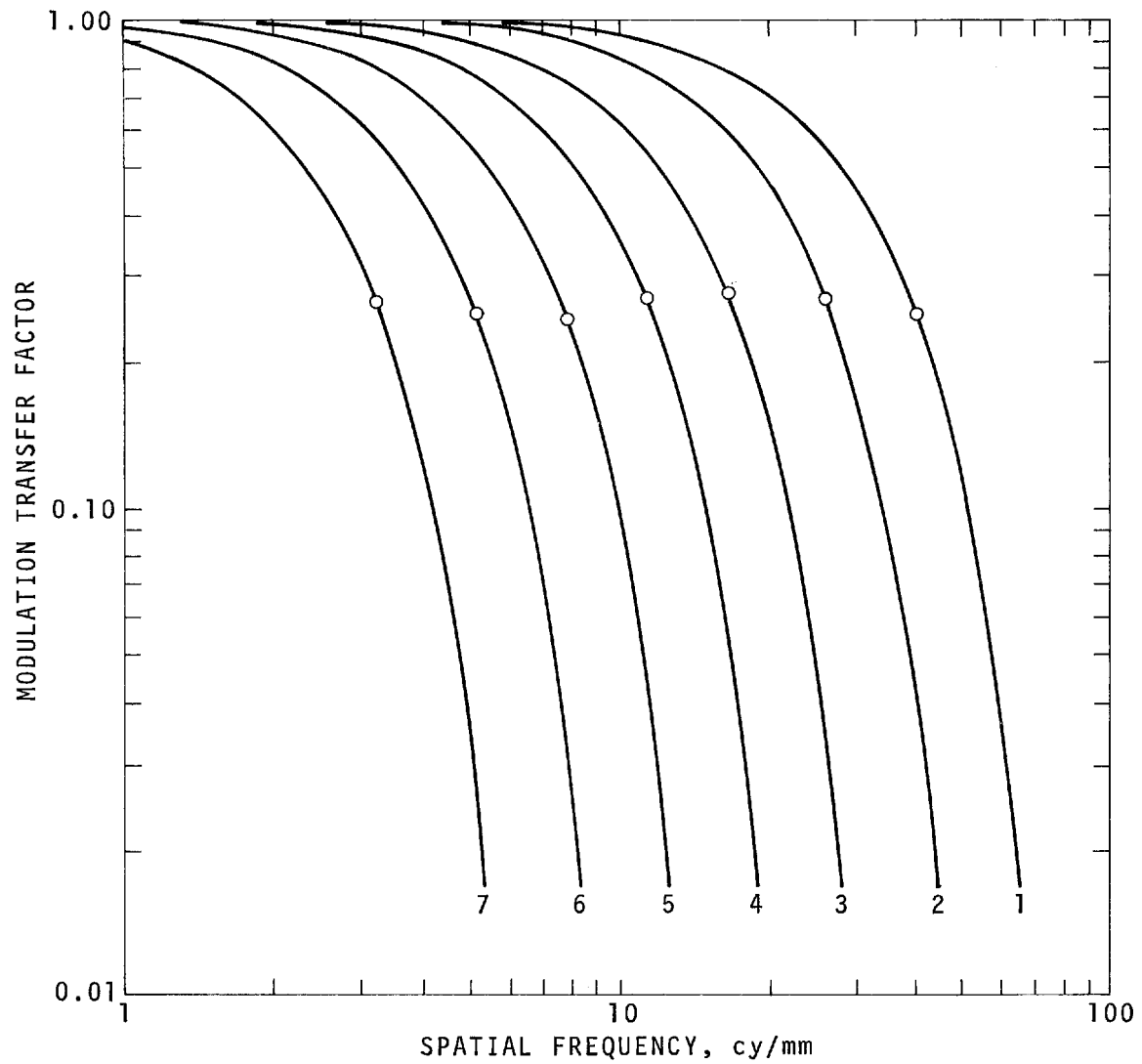
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APPENDIX A

This appendix contains the modulation transfer function curves and prints of one scene at all seven ground resolutions.

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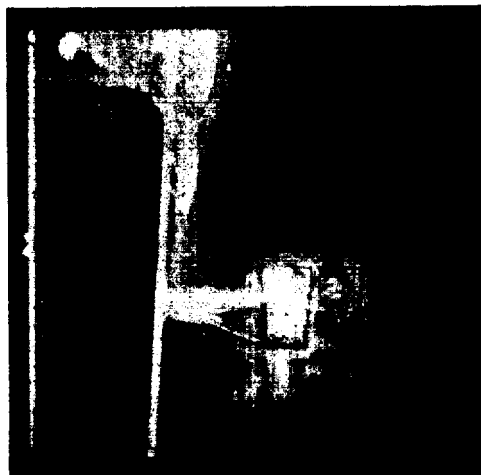
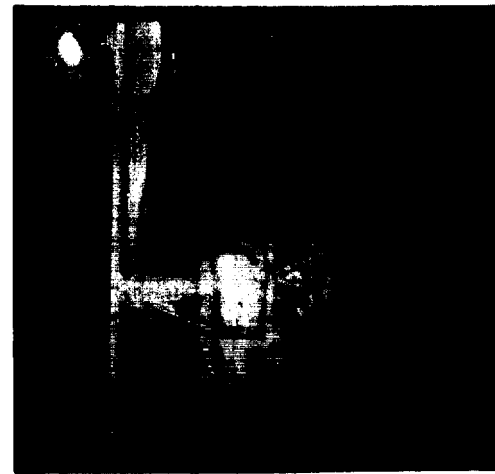
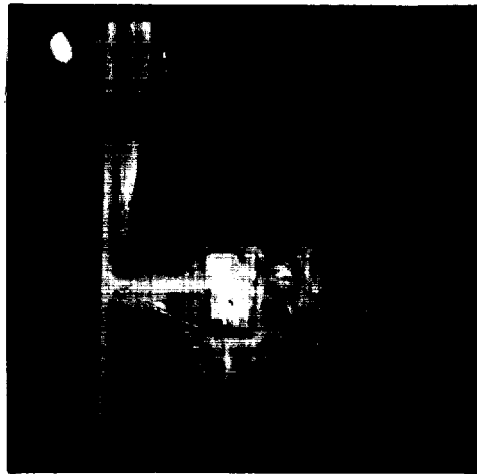
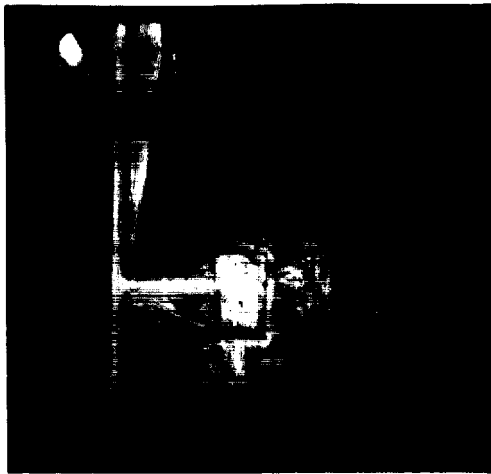
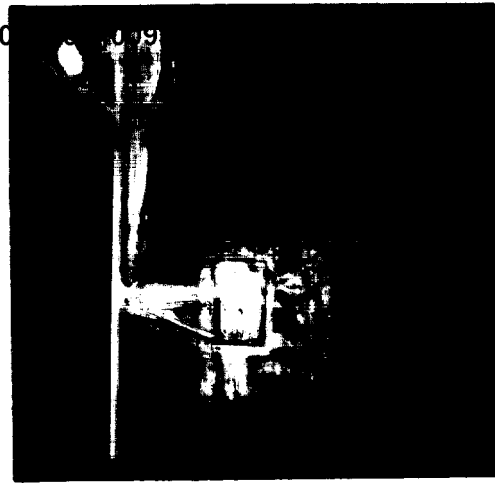
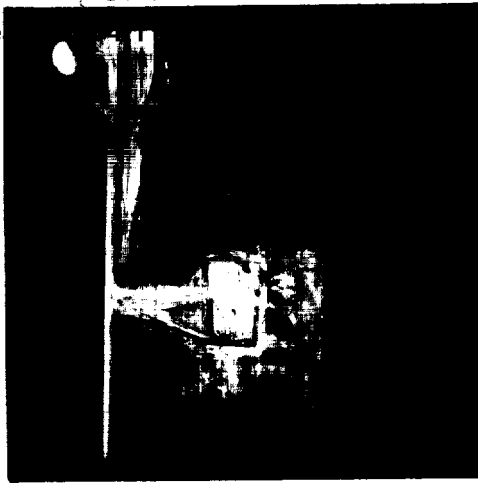
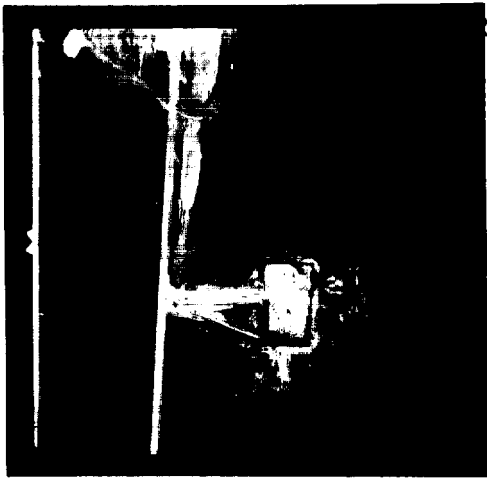
Modulation transfer function curves of the GEMS. The circles indicate the high-contrast three-bar target resolutions, which are shown below.

RESOLUTION OR CURVE NUMBER	SPATIAL FREQUENCY IN cy/mm	
1	40.0	
2	26.3	
3	16.7	
4	11.3	
5	7.8	
6	5.2	
7	3.3	

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APPENDIX B

This appendix contains prints of all 10 targets used in the study:

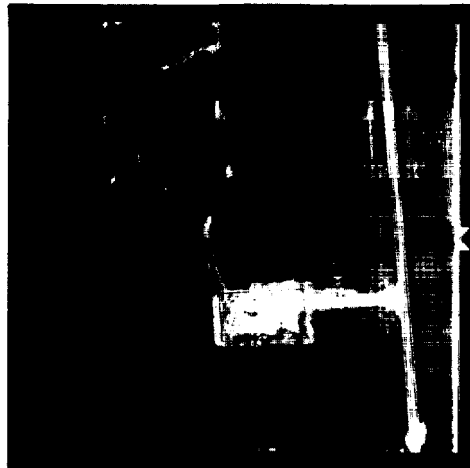
<u>Print</u>	<u>Target Number</u>	
A	6	Minuteman II Launch Control Center
B	1	Minuteman II Launch Facility
C	2	Minuteman II Launch Facility
D	3	Minuteman II Launch Facility (under construction)
E	4	Minuteman II Launch Facility (under construction)
F	5	Minuteman II Launch Facility (under construction)
G	7	Titan II Launch Facility
H	10	Camera Pads (A Mislead)
I	9	Missile Display At Cape Kennedy
J	8	Research and Development Launch Facility (Saturn 1)

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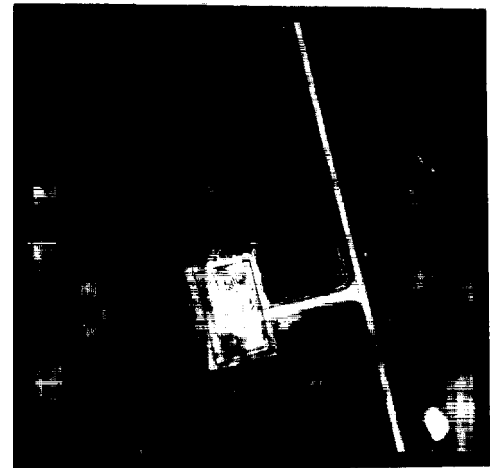
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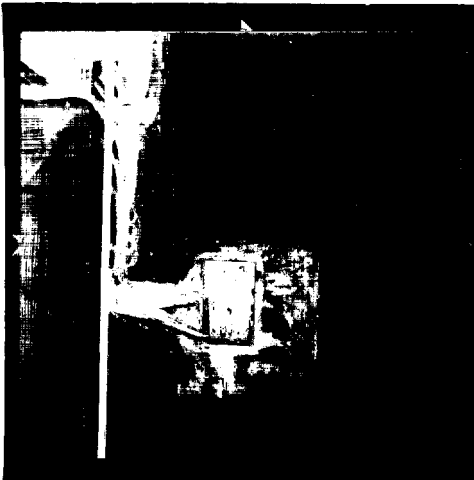
A



B

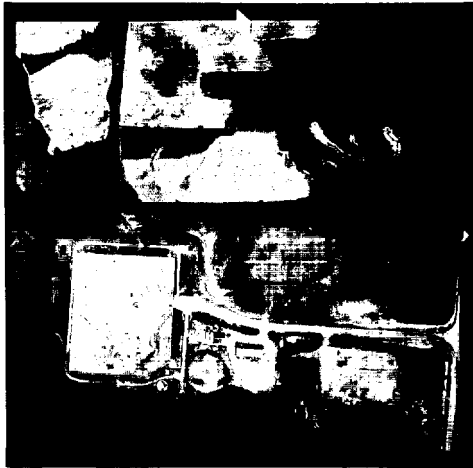


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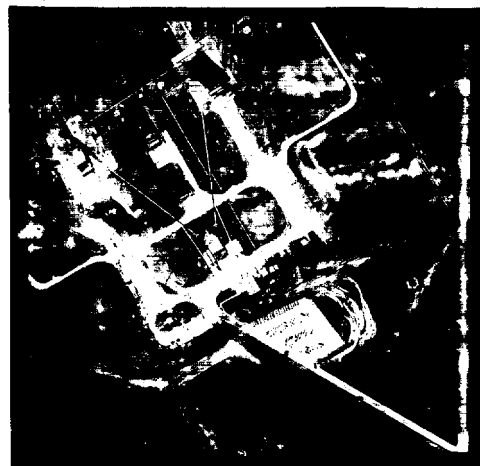
G



H



I



J

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